CLAIMS

What is claimed is:

[c1] A method of analyzing data obtained from well logs taken in a subsurface geological formation having thinly interbedded sandstone and shale layers to determine an expected value of the hydrocarbon pore volume of the formation, comprising:

(a) defining an initial model of the subsurface formation based upon estimates of different bed types and bed-type parameters in the formation, one of said bed-type parameters being aspect ratio, the initial model including a system of log equations for predicting well logs from bed-type parameters;

(b) performing a Monte Carlo inversion to find the ranges of bed-type parameters consistent with the measured well log data; and

(c) determining a statistical distribution for hydrocarbon pore volume representing the expected value for and an uncertainty in the hydrocarbon pore volume from said Monte Carlo inversion.

[c2] The method of claim 1 wherein at least one of said bed types has a finite lateral extent and a positive aspect ratio.

[c3] The method of claim 1 wherein the step of defining the initial subsurface formation model comprises:

(a) selecting an analysis interval;

(b) obtaining average values of the measured well log data over the analysis interval;

(c) formulating a set of reservoir and non-reservoir bed types constituting the selected analysis interval;

(d) determining average values of the petrophysical parameters for each bed type;

(e) assigning relative frequency of occurrence of the different bed types in the formation;

(f) computing log responses for each bed type and over the composite analysis interval;

(g) comparing the computed log responses to the measured log data for consistency; and

(h) repeating steps (b) to (g) until the model parameters are consistent with the measured log data.

[c4] The method of claim 1 wherein the step of performing the Monte Carlo inversion comprises:

(a) estimating uncertainty ranges for each bed-type parameter and for bed frequencies;

(b) generating a random model consisting of random variants for each bed-type parameter and frequency;

(c) computing estimates of average log responses over an analysis interval of the model;

(d) comparing estimated log responses to measured log responses for consistency;

(e) retaining the model only if estimated log responses are consistent with measured log responses;

(f) repeating steps (a) to (e) until a specified number of trials has been completed; and

(g) computing distribution statistics for interval hydrocarbon pore volume and related parameters.

[c5] The method of claim 1 wherein the step of performing the Monte Carlo inversion includes estimating uncertainties for the formation bed properties and for the volume fractions.

[c6] The method claim 1 wherein the step of performing a Monte Carlo inversion is carried out using a programmed digital computer.

[c7] The method of claim 1 wherein the formation model has inputs which comprise a set of parameters describing the thinly bedded formation and has outputs which are the formation average porosity, average water saturation, sand fraction, and average hydrocarbon pore volume.

[c8] The method of claim 7 wherein the accuracy of the input parameters of the formation model are described in terms of probability distributions of parameter values and wherein the step of performing a Monte Carlo inversion involves making a plurality of cases wherein each case comprises a random selection of a parameter value for each input parameter from the probability distribution and calculating a set of outputs.

[c9] The method of claim 8 wherein the step of performing a Monte Carlo inversion is made using a spreadsheet programmed in a digital computer and wherein each case involves a recalculation of the spreadsheet to obtain a resultant set of outputs.

[c10] The method of claim 9 wherein the step of performing a Monte Carlo inversion involves making at least one thousand cases and each resultant set of outputs comprises calculated log responses.

[c11] The method of claim 10 wherein the resultant set of outputs from each case is retained only if that case produces a set of calculated log response outputs which correspond to the input log values within a specified closeness of fit.

[c12] The method of claim 11 further comprising the step of storing the retained sets of outputs and analyzing them for a determination of uncertainty in the estimate of hydrocarbon pore volume.